Incisional Hernias after Vascular Surgery for Aortoiliac Aneurysm and Aortoiliac Occlusive Arterial Disease: Has Prophylactic Mesh Changed This Scenario?

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Abstract

Background Incisional hernia (IH) is an important surgical complication that has several ways of prevention, including modifications in the surgical technique of the initial procedure. Its incidence can reach 69% in high-risk patients and long-term follow-up. Of the risky procedures, open abdominal aortic aneurysmectomy is the one with the highest risk. Ways to reduce this morbid complication were suggested, and prophylactic mesh rises as an important tool to prevent recurrence.

Methods A retrospective cohort study review of medical records of patients undergoing vascular surgery for abdominal aortoiliac aneurysm (AAA) or vascular bypass surgery due to aortoiliac occlusive disease. We identified 193 patients treated between 2010 and 2020. We further performed a one-to-nine matching analysis between the use of prophylactic mesh and control groups, based on estimated propensity scores for each patient.

Results Prophylactic mesh group had a 18% lower risk of IH, compared with the control group (relative risk: 0.82; 95% confidence interval [CI] = 0.74–0.93). The difference in IH rates between the groups compared was 2.6% (95% CI: −19.8 to 25.5). From the perspective of the number needed to treat, it would be necessary to use prophylactic mesh in 39 (95% CI: 35–44) patients to avoid one IH in this population.

Conclusion Use of prophylactic mesh in the repair of AAA significantly reduces the incidence of IH in nearly one in five cases. Our data suggest that there is benefit in the use of prophylactic mesh in open aneurysmectomy surgery regarding postoperative IH development.

Keywords
- hernia
- incisional hernia
- vascular surgery
- aneurysmectomy
- abdominal surgery

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Introduction

Incisional hernia (IH) is a highlighted surgical complication and a constant concern among surgeons. It has an incidence of 5 to 20% in the general population.[1,2] Among the risk factors that contribute to increased IH incidence, obesity (body mass index [BMI] > 30kg/m^2) and the presence of abdominal aortoiliac aneurysm (AAA) are especially high risk for IH development.[1] In patients being treated with AAA, incidence levels of IH as high as 69% have been found in high-risk patients under long-term follow-up.[3,4] Besides these high numbers, incidence ranges from 20 to 38% in most series.[2,4–7]

Despite the similarity between the surgeries, a 3- to 5-fold increased risk of developing an IH after AAA surgery was demonstrated in a comparative study with those undergoing a similar medical condition treatment, such as aortoiliac occlusive disease (AOD) surgery.[6–9] The pathogenesis of AAA and abdominal wall hernias is multifactorial. The hypothesis of a higher incidence of hernias among patients undergoing AAA repair is based on the probable systemic disease of the connective tissue, a condition that is not present in AOD, where the cumulative incidence ranges between 3 and 17%.[2,3,10]

IH has a considerable negative socioeconomic and medical effect. Intestinal obstruction, strangulation, and perforation can happen as a consequence of IH, and emergency surgery may be necessary with an increased risk of mortality. Therefore, negative impact on quality of life, chronic pain, negative body image, cost with medical attention, continuous need of medication, and the mortality risk as consequence of IH complication, explain the proposed prophylactic use of mesh.[1,11]

The relationship between IH and AAA has been frequently questioned in the literature and the comparison with a similar procedure may reinforce the need for prophylactic actions. Not all studies found a significant difference in the incidence of IH between patients undergoing AAA and AOD surgery.[10] Thus, our goal is to identify whether there is a benefit of the prophylactic reinforcement of the mesh after the surgical treatment of AAA in the reality of our patients.

Materials and Methods

A retrospective cohort study review was performed of medical records of patients undergoing vascular surgery for abdominal aortoiliac aneurysmectomy or vascular bypass surgery due to AOD at Hospital de Clínicas de Porto Alegre, a tertiary care public hospital, from 2010 to 2020. The following variables were analyzed: use of prophylactic mesh, age, gender, smoking, high blood pressure (HBP), atherosclerosis, short-term (30 d) complications after surgery (intraoperative, local, and systemic complication), and IH rates within 5 years of follow-up. All these were identified by medical record evaluation and through phone contact. The exclusion criterion was the impossibility of contact to conclude the follow-up.

We performed a one-to-nine matching analysis between the use of prophylactic mesh and control groups, based on estimated propensity scores for each patient.[12] We assessed the propensity score by fitting a logistic regression model for use of prophylactic mesh as a function of the patients' demographic and clinical characteristics: age, gender, smoking, HBP, and atherosclerosis. One-to-nine matched analysis using nearest-neighbor matching was performed based on the estimated propensity scores of the patients; a match was accepted when a patient in the prophylactic mesh group had an estimated score within 0.2 standard deviations of a patient in the control group.[12] We examined the balance in baseline variables using standardized differences, where >10% was regarded as imbalanced.[12]

Data are expressed as numbers (%). Categorical variables were compared using the $\chi 2$ test. McNemar's test with continuity correction was used for the matched comparisons. A value of $p < 0.05$ was considered statistically significant.

This study was approved by Hospital de Clínicas de Porto Alegre Ethics Committee with identification number CAAE 37025920.0.0000.5327 and individual consent form was not necessary.

Results

We found that only a part of the vascular surgery team makes prophylactic use of mesh. This use started in July 2015 after discussions between general surgery and vascular services, but not all the members agreed to use. Patients were divided into a prophylactic mesh group ($n = 13$) and a control group ($n = 180$), from which nine controls for each case were generated (►**Fig. 1**). ►**Table 1** shows the baseline characteristics of the unmatched and propensity score–matched groups. In the unmatched groups, patients were more likely to have used prophylactic mesh if they were female, younger, nonsmoking, and had HBP. After propensity score matching, the baseline patient characteristics were well balanced between the groups.

The characteristics of the study sample after matching by IHs are shown in ►**Table 2**. The mean follow-up between the control group and prophylactic mesh group was similar: 2.9

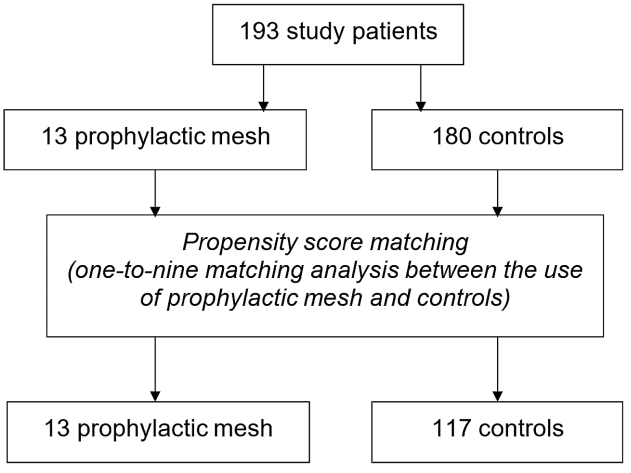

Fig. 1 Patient selection.

Table 1 Baseline patient characteristics in the unmatched and propensity-matched groups

Variables	Unmatched groups			Matched groups		
	Control ($n = 180$)	Prophylactic mesh ($n = 13$)	Standardized differences, %	Control ($n = 117$)	Prophylactic mesh ($n = 13$)	Standardized differences, %
	N (%)	*N* (%)		*N* (%)	*N* (%)	
Gender:						
Male	52 (28.9)	5 (38.5)	20.4	40 (34.2)	5 (38.5)	8.8
Female	128 (71.1)	8 (61.5)		77 (65.8)	8 (61.5)	
Age (y):						
50–60	47 (26.1)	3 (23.1)	7.1	27 (23.1)	3 (23.1)	0.0
60–80	133 (73.9)	10 (76.9)		90 (76.9)	10 (76.9)	
Smoking (yes)	73 (40.6)	6 (46.2)	11.3	55 (47.0)	6 (46.2)	0.0
HBP (yes)	120 (66.7)	10 (76.9)	22.9	87 (74.4)	10 (76.9)	5.9
Atherosclerosis (yes)	34 (18.9)	1 (7.7)	33.4	20 (17.1)	1 (7.7)	28.8

Abbreviation: HBP, high blood pressure.

Table 2 Sample characteristics in the propensity-matched sample ($N = 130$)

Variables	*N* (%)	Incisional hernias	
		N (%)	*p*-Value[a]
Gender:			0.547
Male	45 (34.6)	10 (22.2)	
Female	85 (65.4)	23 (27.1)	
Age (y):			0.254
50–60	30 (23.1)	10 (33.3)	
60–80	100 (76.9)	23 (23.0)	
Smoking (yes)	61 (46.9)	18 (29.5)	0.310
HBP (yes)	97 (74.6)	25 (25.6)	0.861
Atherosclerosis (yes)	21 (16.2)	7 (33.3)	0.361

Abbreviation: HBP, high blood pressure.
[a]Chi-square test.

and 2.7 years, respectively. The patients of the prophylactic mesh group had a 18% lower risk of IH, compared with the control group (relative risk [RR]: 0.82; 95% confidence interval [CI]: 0.74–0.93). The difference in IH rates between the groups compared was 2.6% (95% CI: −19.8 to 25.5). From the perspective of the number necessary to treat (NNT), it would be necessary to use prophylactic mesh in 39 (95% CI: 35–44) patients to avoid one IH in this population (►**Table 3**). The description of complications after surgery by matched groups are shown in ►**Supplementary Table S1**.

Discussion

The relationship between IH and abdominal aortic aneurysm and ways to avoid hernia has been questioned in the literature. The negative impact on quality of life, chronic pain, negative body image, cost of medical care, continued need for analgesic medication, and, in the worst cases, intestinal strangulation and death from IH complications explain the proposed prophylactic mesh use.[1,13] After AAA repair, reoperation rates of 8 and 11% for IH treatment were reported, a non-negligible number for patients with such morbidities.[7]

The primary event in the development of AAA is related to the proteolytic degradation of the extracellular matrix proteins elastin and collagen, in which the matrix metalloproteinases are involved.[14]

Risk factors associated with AAA are smoking, gender (male), advanced age, atherosclerosis, family history, other arterial aneurysms (e.g., iliac, femoral, popliteal, intracranial), connective tissue disorder (e.g., Marfan, Ehlers–Danlos, Loeys–Dietz syndromes), prior history of dissection, and prior history of surgery or instrumentation.[15]

The risk factors for IH are advanced age, male gender, BMI $\geq 27\ kg/m^2$, diabetes, chronic obstructive pulmonary disease,

Table 3 Proportion of patients with incisional hernias by use of prophylactic mesh in propensity score–matched groups ($N = 130$)

Use of prophylactic mesh	Incisional hernias				NNT	95% CI
	N (%)	RR	95% CI	*p*-Value[a]		
Propensity score–matched groups:				0.002		
Control group	30 (25.6)	1.00			39.0	35.1–44.1
Prophylactic mesh group	3 (23.1)	0.82	0.74–0.93			

Abbreviations: CI, confidence interval; NNT, number needed to treat; RR, relative risk.
[a]McNemar's test with continuity correction.

chronic kidney disease, immunosuppression, use of corticosteroids, anemia, uremia, malnutrition, collagen-related diseases, smoking, neoplasia, surgical-site infection, abdominal aortic aneurysm, and emergency surgery.[8,16–19] Patients with abdominal aortic aneurysm and obese individuals are of especially high risk for IH development.

Although collagen tissue composition, genetic mutation, clear biological indicator, or significant relationship between risk factors have not yet been fully elucidated in AAA formation and abdominal wall hernias, it is believed that an underlying imbalance between collagen Type 1 and 3 is the common point in the pathophysiology of these conditions.[2,7,10,20] There are a few studies in the literature that compare the groups in terms of IH development between AAA and AOD, and it has been reported that the AAA group has a greater IH rate, up to a median of 5-fold increased risk.[7,8,21]

In a study comparing AAA and AOD repair, a BMI of 25 kg/m^2 or higher was found to be an independent risk factor for IH.[10] Obesity is associated with a higher intra-abdominal pressure and wound-healing complications as a consequence of decreased vascularity of adipose tissue. The synthesis of mature collagen is impaired in hypoxic wounds, resulting in weakened tissue formation.[1]

Henriksen et al[20] conducted a comprehensive multicenter study that included 838 and 1,759 patients who underwent open elective surgery for an AOD and AAA, respectively. High BMI and AAA repair were found to be independent risk factors for IH formation in individuals receiving aortic reconstructive surgery in this study. The main risk period for the development of an IH is during the first 2 years after surgery.[6,20]

Studies concerning the incidence of IH in patients with abdominal aortic aneurysm and the benefit of prophylactic mesh were done worldwide; nonetheless, few of them provided good evidence to support mesh reinforcement. The PRIMAAT trial,[4] conducted by Muysoms and colleagues, in patients with AAA found that cumulative incidence of IH was 28 versus 0% in the nonmesh and mesh groups, respectively.

Further, the PRIMA trial[1] provides Level One evidence for onlay mesh prophylactic reinforcement after midline laparotomy in high-risk patients, those with AAA, or BMI of 27kg/m^2 or higher. In this study, in relation to patients with AAA, the authors found that prophylactic mesh significantly reduced the incidence of IH: 43% incidence with primary suture versus 16% with onlay mesh ($p = 0.008$) and 19% with sublay mesh ($p = 0.03$). The closure of the abdominal wall was performed by vascular and gastrointestinal surgeons, urologists, and gynecologists.[1]

Concerns about complications related to mesh placement have been investigated. In the PRIMA trial, no evidence of increased frequency of surgical-site infections, readmissions, or reinterventions was found when comparing primary suture or mesh reinforcement (onlay and sublay).[1] Seroma was the most common complication after onlay mesh; however, this mild surgical complication had no further adverse outcomes for the patients.[1] In the present study, we found no statistical difference between surgical-site complications, not even in the incidence of seroma.

A meta-analysis performed in 2018 by Indrakusuma et al[7] compared four studies on the use of prophylactic mesh after surgery for AAA. The four comparative studies analyzed the use of prophylactic mesh versus suture for a 4:1 wound ratio. The result was a significant reduction in IHs compared with standard closed suture (RR: 0.27; 95% CI: 0.11–0.66) and NNT of four. Compared with these meta-analysis results, our NNT findings may be a consequence of our small number of cases ($N = 13$).

To the best of our knowledge, onlay mesh reinforcement plus small bite suture technique produces the most important preventive effect on IH.[1,3,4] It is important to emphasize that the use or not of the prophylactic mesh does not change the current indication of suturing the aponeurosis with small bites and long-lasting absorbable suture.

This study has some limitations. First, it was retrospective and observational, without randomization. Even though we adopted propensity score matching to adjust for differences in baseline characteristics, there may still have been bias in the form of confounders that were not measured. However, the baseline characteristics of selected patients were well balanced in the propensity score–matched groups. Second, due to the small sample size of this study (in part as a consequence of the high mortality in these individuals undergoing AAA surgery or bypass for AOD), at times reoperatives, findings may not generalize to the larger population. However, although large, randomized trials are necessary to confirm these results, these may not be easy to achieve.

Conclusion

Most patients undergoing AAA or AOD surgery are elderly and have multiple medical conditions that increase the risk of surgical complications. Use of prophylactic mesh in patients undergoing surgery for AAA may prevent future surgery for the treatment of IH, a procedure with inherent risks of complications. In addition, there is the benefit of avoiding the considerable negative socioeconomic and medical effects caused by an IH.

Based on this retrospective study, we suggest that there is benefit to the use of prophylactic mesh after surgery for abdominal aortic aneurysm, with a reduction in IH incidence in nearly one in five cases of IH without an increase in the number of postoperative complications. These results, however, need to be interpreted with caution and warrant prospective randomized trials for confirmation.

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Conflict of interest
The authors declare no conflict of interest related to this article.

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